US Army Corps of Engineers®
Engineer Research and Development Center

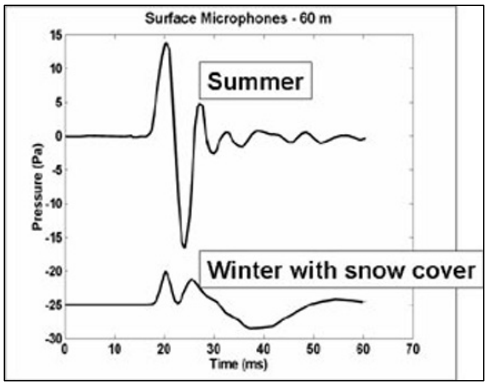
Snow Acoustics

Problem

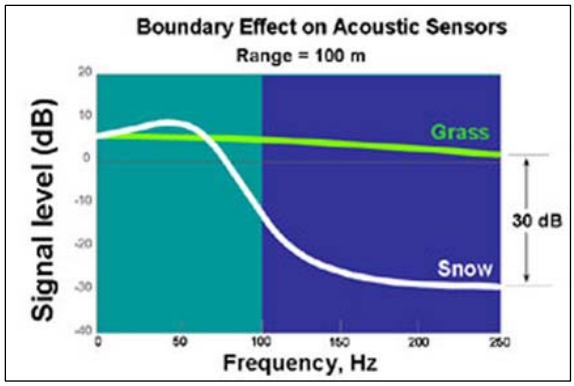
The interaction of sound energy with the ground is an important aspect contributing to the understanding of outdoor sound propagation. It affects predictions of traffic, industrial, or blasting noise levels, which are increasingly important in mitigating or preventing community noise problems and assessing environmental impacts of various activities. Snow is of interest in these applications because it is the most absorbent, naturally occurring ground cover.

Description

Researchers at the Engineer Research and Development Center's Cold Regions Research and Engineering Laboratory (ERDC-CRREL) have conducted many measurements of outdoor sound propagation when seasonal snow was present. As a result of this research, scientists have determined the acoustic parameters needed to predict sound levels under winter conditions, and also have developed methods to use acoustic waves to characterize and measure parameters of interest in snow cover dynamics.



a. Pistol waveforms.



b. Boundary effect.

Figure 1. (a) Waveforms recorded 60 m from a blank pistol shot, with and without snow cover. (b) Frequencies above 100 Hz are strongly attenuated by the snow.

As an example, the waveforms (Figure 1a) show an acoustic pressure wave recorded by a microphone 60 m from the shot. The loud "bang" recorded in summer without snow is reduced to a quieter "whoomp" in winter by the snow cover. These recordings show that not only is the sound quieter, it also is longer in duration, or distorted, when a snow cover is present.

Any type of sensor system that listens for certain sounds will perform differently when snow is present. Figure 1b shows the frequency content of the waveforms measured with the blank pistol. This display shows that frequencies above about 100 Hz (bass frequencies) are strongly attenuated. This distortion must be taken into account if the system is to perform well under winter conditions.

Expected Products

Research on the effects of a snow cover on acoustic wave propagation has led to better understanding of how acoustic waves interact with snow, and to the development of new acoustic methods for remote and automatic determination of snow cover depth (see Figure 2) and permeability. Ongoing research has been documented in journal articles and reports.

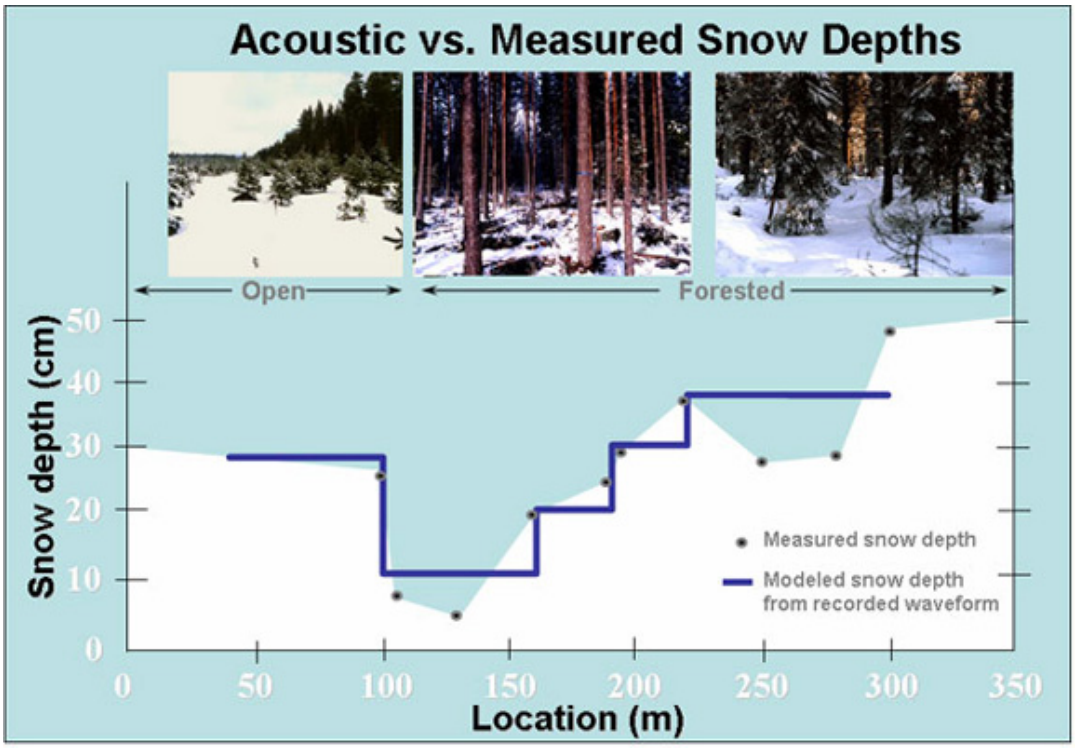


Figure 2. Measurements were conducted at the edge of a forest. Because of radiation from the dark tree trunks, the snow cover was much shallower just inside the edge of the forest, and acoustic waveform measurements were able to track these changes in snow depth.

Potential Users

This research will benefit researchers and engineers involved in the design of autonomous sensor systems, snow and ice investigations, and predictions of sound levels for noise mitigation and/or environmental impact estimates.

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